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⑬

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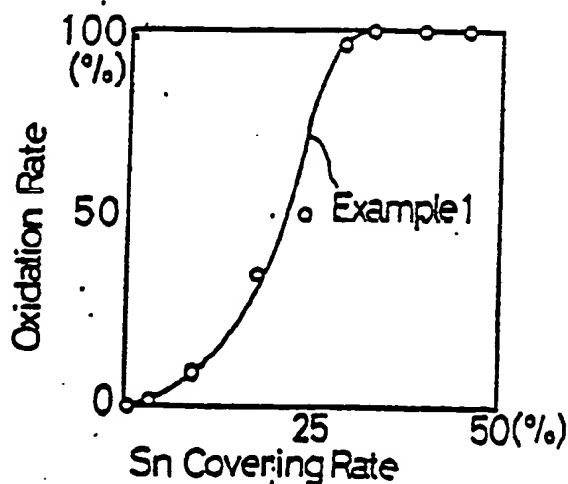
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⑬ Oxidation catalyst for gas decomposition.

⑭ An oxidation catalyst for decomposing chemical compounds, in which tin covers at least one precious metal of platinum, palladium, Iridium and rhodium,

and a surface covering rate of the tin is approximately 10 to 90% with respect to the precious metal.

FIG 1



EP 0 408 528 A1

## OXIDATION CATALYST FOR GAS DECOMPOSITION

### BACKGROUND OF THE INVENTION

#### Field of the Invention

The present invention relates to an oxidation catalyst for decomposing a compound such as carbon monoxide, formalin in a gas including oxygen for use in an air cleaner, a combustion gas cleaner or purifier, a gas sensor, a deodorizer, a gas refiner or the like.

#### Description of the Background Art

Conventionally, a precious metal such as platinum, palladium or the like is used as an oxidation catalyst for decomposition of a harmful gas such as carbon monoxide, formalin or formaldehyde or the like in a gas including oxygen. However, such an oxidation catalyst exhibits oxidation ability at a high temperature of approximately 400 °C, which restricts its utilization and application range or fields.

### SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an oxidation catalyst for decomposition of a harmful compound such as carbon monoxide, formalin or the like in a gas including oxygen, free from the aforementioned defects and disadvantages of the prior art, which is capable of performing at a low temperature range between a room temperature to approximately 150 °C.

In accordance with one aspect of the present invention, there is provided an oxidation catalyst for decomposing chemical compounds, comprising at least one precious metal of platinum, palladium, iridium and rhodium, and tin covering the precious metal, a surface covering rate of the tin being approximately 10 to 80% with respect to the precious metal.

### BRIEF DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will more fully appear from the following description of the pre-

ferred embodiment with reference to the accompanying drawings, in which:

Fig. 1 is a graphical representation illustrating a relation between a tin covering rate and a reaction rate in one example using an oxidation catalyst according to the present invention; and Fig. 2 is a graphical representation illustrating a relation between a temperature and a reaction rate in a comparative example using a conventional oxidation catalyst.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in detail in connection with its preferred embodiments with reference to the accompanying drawings.

An oxidation catalyst for decomposition of a harmful gas such as carbon monoxide, formalin or formaldehyde or the like according to the present invention includes one of precious metal such as platinum, palladium, iridium and rhodium and tin, and the surface covering rate of tin with respect to the precious metal is approximately 10 to 90%.

At least one metal black of platinum, palladium, iridium and rhodium constituting a component of the oxidation catalyst is prepared by electrolysis of a chloride solution of the metal. After cleaning the obtained metal black by using dilute sulfuric acid solution, tin atom is deposited over the surface of the cleaned metal black in an electrolytic solution including a tin compound so that a surface covering rate of the tin with respect to the metal black is approximately 10 to 90%, to obtain a tin-modified catalyst. The tin-modified catalyst is then washed by water in inert gas atmosphere and is then dried at below 100 °C to obtain an oxidation catalyst according to the present invention.

The surface covering rate of the tin with respect to the metal black is preferably determined to approximately 10 to 90% in order to oxidize to decompose a harmful gas such as carbon monoxide, formalin or the like in a gas including oxygen at a low temperature range between a room temperature and approximately 150 °C by using the obtained oxidation catalyst according to the present invention.

When the surface covering rate of the tin with respect to the metal black is less than 10%, the oxidation ability can not be obtained at the above described low temperature, and, when the surface covering rate of the tin with respect to the metal black is more than 90%, the oxidation speed is not

sufficient.

By contacting a mixture gas including the oxygen and the harmful gas such as carbon monoxide, formalin or the like with the oxidation catalyst of the present invention, the harmful gas can be oxidized to carbon dioxide or the like. The oxygen amount in the mixture gas is at least equivalent amount for completely oxidizing the harmful gas such as the carbon monoxide, the formalin or the like, and hence there is no need to add an excess amount of oxygen more than the amount required for the complete oxidation into the mixture gas.

In practice, a tin compound may be coated on a precious metal such as platinum, palladium, iridium or rhodium carried on a catalyst carrier.

Examples of the present invention will now be described in detail, and the present invention is not restricted to the Examples.

#### Example 1:

A platinum wire having a diameter of 0.3 mm was attached under pressure to a platinum net having a dimension of 37 mm x 50 mm for an electrochemical treatment. An electrodeposition of the platinum net was carried out in a solution including 3% by weight of chloroplatinic acid and 0.03% by weight of lead acetate to deposit platinum black on the platinum net. Anode-cathode treatment of the resulted platinum net was repeated to clean it in an electrochemical manner in 0.5M ( $M = \text{mol/dm}^3$ ) of sulfuric acid solution as an electrolytic solution.

The true surface area of the platinum black was 1266.7  $\text{cm}^2$ , and the roughness factor of the same was 19.28.

Tin atom was deposited on the obtained platinum net in 0.5M of sulfuric acid electrolytic solution including  $10^{-5}$  to  $10^{-4}$  M of tin sulfate at a deposition potential of 0.2V vs. RHE to prepare a tin-modified platinum catalyst. In this embodiment, by varying the deposition time, 8 kinds of tin-modified platinum catalysts having different tin covering rates were prepared, as shown in Fig. 1.

The obtained tin-modified platinum catalysts were washed by water in an argon gas atmosphere to remove the sulfuric acid component, and then the washed tin-modified platinum catalysts were dried at 80 °C while an argon gas was circulated.

Each of 8 dried tin-modified platinum catalysts was filled up in a reaction tube having a dimension of an internal diameter of 8 mm x a length of 37 mm to obtain a reactor. Then, a mixture gas of  $\text{CO} + \text{O}_2 + \text{He}$  at a mixture ratio of 3:2:28 was flowed in the reactor at a flow speed of 8.8 ml/min. to carry out a quantitative analysis of CO,  $\text{O}_2$  and  $\text{CO}_2$  at a temperature of approximately 290 to 430K by

using gas chromatography. As a result, as shown in Fig. 1, the oxidation rate of 100% was obtained at the tin covering rate of 35%.

The tin covering rate was measured from reduction of hydrogen elimination wave by using a single pulse method (potential sweep speed of 0.01 V/s). The true surface area of the platinum black was 368.7  $\text{cm}^2$  and the roughness factor of the same was 5.58.

#### Example 2:

A tin-modified platinum catalyst having a tin covering rate of 94% was prepared in the same manner as Example 1 and was filled up in the reaction tube to obtain a reactor in the same manner as Example 1. Then, a mixture gas of  $\text{CO} + \text{O}_2 + \text{He}$  at a mixture ratio of 3:2:28 was flowed in the reactor at a flow speed of 8.8 ml/min., and CO oxidation reaction rate was measured at a certain reaction temperature of an absolute temperature range between 290 and 430K. A quantitative analysis of CO,  $\text{O}_2$  and  $\text{CO}_2$  was carried out by using the gas chromatography. As a result, as shown in Fig. 2, the CO oxidation rate of 100% was obtained at the absolute temperature of 420K.

#### Comparative Example:

By using a platinum catalyst prepared in the same manner as Example 2, except that no tin was coated, a test was carried out in the same manner as Example 2 except a reaction temperature of an absolute temperature range between 290 and 495K. In this case, as shown in Fig. 2, the CO oxidation rate was 2% at the absolute temperature of 490K.

#### Example 3:

A test was carried out in the same manner as Example 1 using a tin-modified catalyst, except that palladium black, iridium black or rhodium black was deposited on the platinum net by the electrodeposition, to obtain the same effects and advantages as those of the Example 1.

#### Example 4:

By using the tin-modified platinum catalyst prepared in Example 2, a test was carried out in the same manner as Example 2, except a mixture gas of  $\text{HCHO} + \text{O}_2$  at a mixture ratio of 1:10 was used. In this case, the oxidation rate of HCHO was 100% at the absolute temperature of 320K.

It is readily understood from the above description that the harmful gas such as carbon monoxide, formalin or the like can be oxidized and decomposed at a low temperature of a room temperature to approximately 150 °C by using a tin-modified oxidation catalyst according to the present invention. Hence, this catalyst can be widely used in various fields.

Although the present invention has been described in its preferred embodiments, it is readily understood that the present invention is not restricted to the preferred embodiments and that various changes and modifications can be made by those skilled in the art without departing from the spirit and scope of the present invention.

#### Claims

1. An oxidation catalyst for decomposing chemical compounds, comprising:  
at least one precious metal of platinum, palladium, iridium and rhodium; and  
tin covering the precious metal, a surface covering rate of the tin being approximately 10 to 90% with respect to the precious metal.
2. The catalyst of claim 1, wherein the chemical compounds include carbon dioxide and formalin.
3. The catalyst of claim 1, wherein the precious metal is a metal black.

FIG 1

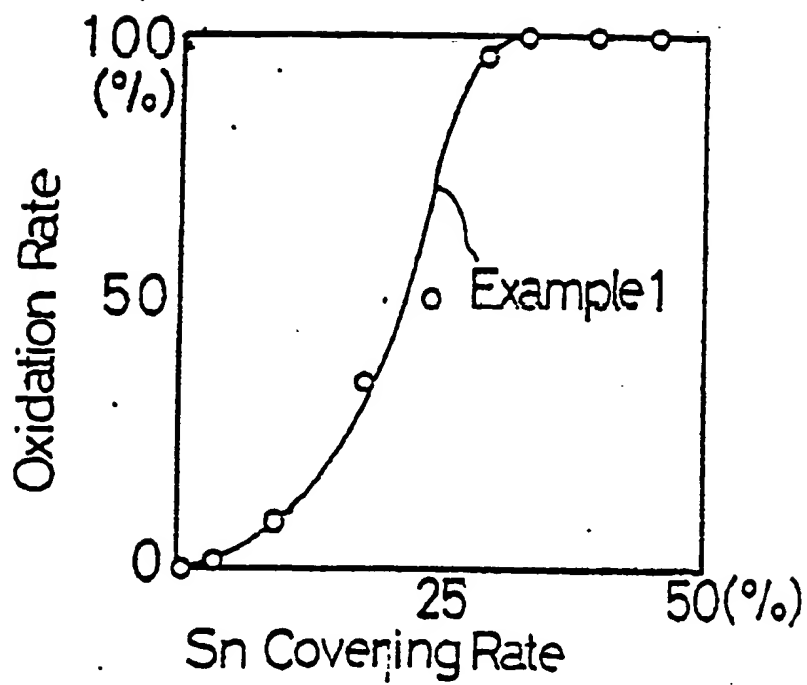
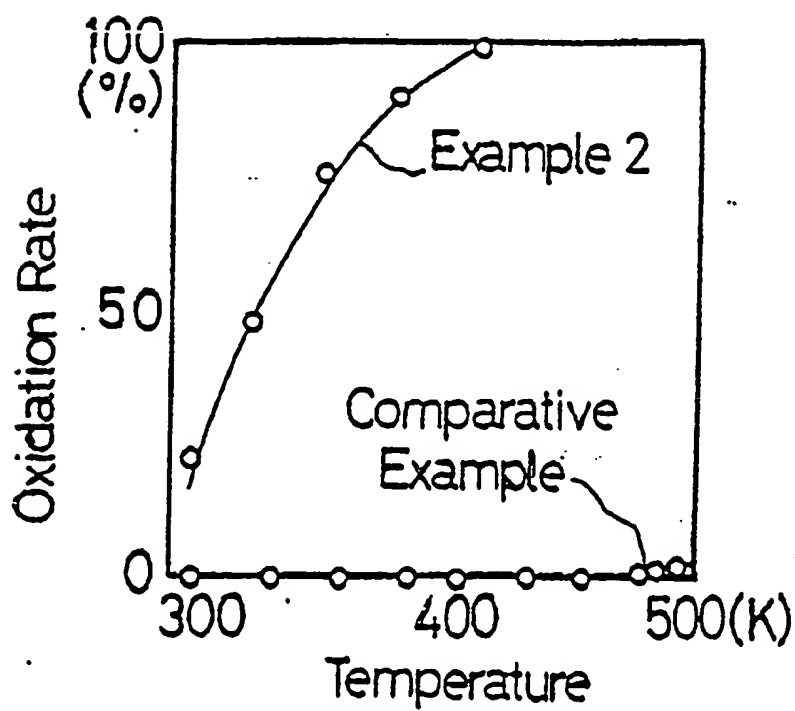


FIG. 2





European Patent  
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# EUROPEAN SEARCH REPORT

Application Number

EP 90 83 0322

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	FR-A-2 203 676 (TOA NENRYO KOGYO) * Page 11, lines 1-18 * ---	1	B 01 D 53/36 B 01 J 23/62
A	EP-A-0 266 875 (HITACHI) * Claim 1 * ---	1,2	
A	EP-A-0 129 406 (UNITED KINGDOM ATOMIC ENERGY AUTHORITY) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 01 D B 01 J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15-10-1990	Examiner BOGAERTS M.L.M.
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EP 90 83 0322 (90/04)